

WHAT IS CLAIMED IS:

1. A reflective mask blank having a programmed defect, comprising a substrate and a reflective multilayer film formed on the substrate to reflect exposure light incident to the reflective multilayer film, the reflective multilayer film having a principal surface provided with a step portion for causing a phase change in reflected light obtained by reflecting the exposure light.
2. A reflective mask blank having a programmed defect, comprising a base body comprising a substrate and a reflective multilayer film formed on the base body to reflect exposure light incident to the reflective multilayer film, the base body having a principal surface provided with a base pattern comprising a predetermined irregularity, the reflective multilayer film formed on the base pattern having a principal surface provided with a step portion corresponding to the base pattern so that the reflective multilayer film has the programmed defect.
3. A reflective mask blank having a programmed defect as claimed in claim 2, wherein the base pattern is formed by a patterned thin film.
4. A reflective mask blank having a programmed defect as claimed in claim 3, wherein the thin film forming the base pattern is made of a material containing Cr or Ta as a main component.
5. A reflective mask blank having a programmed defect as claimed in claim 4, wherein the thin film forming the base pattern is made of a material containing Cr and at least N or a material containing Ta and at least B.
6. A reflective mask blank having a programmed defect as claimed in any one of claims 2 through 5, further comprising a base intermediate film formed between the base pattern and the reflective multilayer film.
7. A reflective mask blank having a programmed defect as claimed in any one of claims 1 through 6, wherein the reflective multilayer film comprises Mo and Si films alternately laminated.

8. A reflective mask blank having a programmed defect as claimed in any one of claims 1 through 7, further comprising an absorber layer made of a material absorbing the exposure light and formed on the reflective multilayer film.

9. A reflective mask blank having a programmed defect as claimed in any one of claims 1 through 8, wherein the exposure light is EUV light.

10. A reflective mask blank having a programmed defect as claimed in any one of claims 1 through 9, wherein the reflective multilayer film has a surface roughness greater than 0 nm and not greater than 0.2 nm in root-mean-square roughness (Rms).

11. A reflective mask having a programmed defect, comprising a reflective mask blank having a programmed defect claimed in claim 8 and a mask pattern formed on the absorber layer of the reflective mask blank.

12. A substrate for use in producing a reflective mask blank having a programmed defect or a reflective mask having a programmed defect, the base body having a principal surface with a patterned thin film formed thereon to provide a predetermined irregularity on the principal surface.

13. A method of producing a reflective mask blank comprising a base body comprising a substrate and a reflective multilayer film formed on the base body to reflect exposure light, the method comprising the steps of:

forming a base pattern comprising a predetermined irregularity on a principal surface of the base body; and

forming the reflective multilayer film on the base pattern to thereby form a step portion on a principal surface of the reflective multilayer film corresponding to the base pattern so that a programmed defect is formed on the reflective multilayer film;

the reflective multilayer being deposited by sputtering in a condition that the base body is faced to a surface of a sputter target for deposition of the

multilayer reflective film and the base body is rotated around a rotation axis which is a normal passing through the center of the principal surface of the base body.

14. A method of producing a reflective mask blank as claimed in claim 13, wherein the base body is placed so that the principal surface of the base body is inclined at an angle with respect to the surface of the sputter target.

15. A method of producing a reflective mask blank as claimed in claim 14, wherein the angle of the base body with respect to the surface of the sputter target is controlled to thereby control at least one of the height, the size, and the shape of the step portion formed on the principal surface of the reflective multilayer film.

16. A method of producing a reflective mask blank as claimed in any one of claims 13 through 15, wherein an absorber layer made of a material absorbing the exposure light is formed on the reflective multilayer film.

17. A method of producing a reflective mask, the method comprising the step of preparing a reflective mask blank having a programmed defect by a method claimed in claim 16 and forming a mask pattern on an absorber layer of the reflective mask blank.